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# ON THE PROBLEM OF APPLIED MATHEMATICS

By Dr. JAMES H. TAYLOR

THE GEORGE WASHINGTON UNIVERSITY

ALMOST anything is tremendously complicated. Frazier set out to write a monograph on a certain cult of ancient Greece and ended up with his famous work of twelve volumes entitled "The Golden Bough." Consider a simple hobby like stamp collecting. One is soon involved in a maze of pertinent details such as kinds of paper, methods of printing, types of perforations, colors and shades which even the Bureau of Standards might find difficult or impossible to determine, and finally watermarks, overprints, surcharges and forgeries.

In comparison with any other well-recognized body of knowledge, mathematics must be relatively simple. Consider for instance a given mathematics, that is, a branch of mathematics like Euclidean geometry or projective geometry or real variable. You perhaps know how any one of these subjects may be set up. After two thousand years of experience the "natural" way appears to be as follows. One lists a set of undefined elements and relations, and a set of unproved propositions involving them; and from these all other propositions or *theorems* are to be obtained by the methods of formal, deductive logic. The unproved propositions which are imposed are called axioms, postulates or assumptions. For example, in projective or in Euclidean geometry "point" and "line" are undefined elements; the relation "on" is an undefined relation. One of the axioms reads as follows: If A and B are distinct points there is at least one line on both A and B.

It is important to appreciate that a mathematics seems to be completely determined once the postu-

lates have been listed. One's skill in the field is measured by his ability to rearrange the statements implied by the postulates so as to exhibit other interesting relations. In analytic geometry a student is given the equation of a certain circle. Of course all the properties of the particular circle are incorporated in the coefficients of the equation. The student thinks "buried" is a better word. At any rate the problem is to extract from the coefficients the information asked for. The development of a mathematics from the postulates is closely paralleled by a variety of solitaire called idiot's Delight. In this game all the cards are exposed; therefore all the possibilities are revealed once the tableau is laid out.

A postulational setup for a branch of mathematics is the complete "blue print" for the whole subject. In Veblen and Young's "Projective Geometry" this postulational material requires perhaps not more than twenty pages for its presentation; the remaining eight hundred pages are given over to the development of the theorems. The complete structure may be regarded as a "model" constructed according to the blue print. The construction is carried out by the processes of formal logic. I do not feel competent to make any statements regarding the methods of logic. However, these procedures seem to be extremely reliable; they seem to be as dependable as any so-called "law of nature." Some physicist, I believe, has called attention to the slight probability that one hundred monkeys seated before one hundred typewriters would each write the preamble to the Constitution of the United States. Personally, I think the probability that this should happen is about the same as that one hundred competent persons starting with the same system of postulates should fail to arrive at mathematics which were consistent with each other.

That the initial set of assumptions should be consistent, that is, not self-contradictory, is of course a logical necessity. This brings us to our first observation concerning applied mathematics. By "applied mathematics" we shall mean a correspondence between the elements and relations of a mathematical system and those of some other system such as a physical system or a social system if that is possible. The example we have in mind at this stage, however, is an instance of "applied physics"; that is, physics applied to the mathematics. For this is the method by which we test the logical consistency of a system of postulates. Such a system is accepted as being consistent if, when the undefined elements and relations are identified with observed elements and relations of a physical system, the postulates are observed to hold in the physical system. Here too, "seeing is believing." Just recently some of you heard Professor Von Neumann discuss the consistency of a certain logical system by an appeal to the laws of quantum mechanics. I well recall that following a lecture by Professor Veblen a number of years ago some one made the observation that "physics seemed to be becoming mathematics." In reply Veblen said that if he were crowded a bit he would have to admit that "mathematics is physics."

After a given mathematics has been examined in this manner and "certified" it may, of course, be used to test the validity of other branches of mathematics. Thus the consistency of a system of postulates for a geometry may very well be established by means of the properties of the real number system.

When a mathematics has become sufficiently advanced to go over to a postulational formulation, it has also become quite artistic in nature. Aesthetic considerations require that the fundamental assumptions shall be independent among themselves; that is, no one of them shall be a logical consequence of the remaining ones. Here again, we may employ an empirical test. One merely looks about and attempts to observe a set of objects with certain relations between them, and such that if they are identified with the undefined elements and undefined relations of the mathematical scheme, it is observed that all the postulates except one are satisfied and it is contradicted. If such a concrete representation can be observed we accept its mere existence in the physical world as conclusive that the violated postulate is not a logical consequence of the others. Such a test may be easily applied in a given case, and on the other hand it may be very difficult to find a suitable representation. It required about two thousand years to conclude that the parallel axiom of Euclid is really independent of the remaining postulates of the Euclidean geometry. You will recall this assumption states: Through a given point there exists one and only one line which is parallel to a given line. Scholars in the field believe that Euclid himself was concerned with the possible redundancy of this postulate. Such concern indicates that the artistic structure of the subject was well appreciated even in his time. Naturally the frontal attack on the problem was to attempt a proof of the axiom as a theorem derived from the remaining axioms. This turned out to be one of the great classical problems of mathematics. The problem had a simple formulation and the answer was not known. It was the kind of a problem an "amateur" might solve and thereby become famous.

A little over one hundred years ago the problem was finally disposed of by the technique of the "reducto ad absurdum" proof. This was simply to accept all the other postulates of Euclidean geometry and to deny the parallel postulate; then proceed to develop the resulting subject. If a contradiction

appeared it would be concluded that the assumptions made were inconsistent, and hence that the parallel assumption was really a consequence of the others since its denial led to a contradiction in the system. However, no contradiction appeared and thus there arose a non-euclidean geometry. This was the first instance of an abstract geometry developed quite independently of the physical world. It was like a new synthetic sugar created in a chemist's test-tube. Its production marked a mathematician as being more than merely a recording engineer.

This emergence of a fully fledged abstract geometry in no wise related to the world of experience as then known was an amazing event. It could not have appeared much sooner in the time scale. In the first place its development depended upon a certain technique in abstract mathematics which required centuries to establish, and in the second place it probably would have been rejected by an earlier generation because of its conflict with their intuitive notions. With the advent of relativity theory we see that the non-euclidean geometry may very well have a concrete representation in the physical world.

I would guess that the art of painting was initially merely a recording process. It must have been a long time before any philosophy of painting came into being. However, later on the painter attempted to portray conceptual objects, whereas in the early stage the effort was simply to record perceptual objects. Mathematics has no doubt followed a similar life pattern. At first the symbols 1, 2, 3, etc., were names of an ordered sequence in close association with sets of perceptual objects. The symbols were made to correspond with perceptual objects, and operations or relations involving the symbols were introduced which were in correspondence with certain observed physical processes. A correspondence which is preserved under the corresponding operations is called an isomorphism. This notion of isomorphism is inherent is every problem of applied mathematics.

After the rules of the "arithmetic" had been formulated in conformity with observed physical processes the mathematics became something more than merely a picture. It had acquired a structure, and in order to lend meaning in all cases when the rules were applied to the symbols, new symbols or numbers were added. Thus certain elements in the mathematics may well be purely conceptual and not have their counterpart, that is, corresponding elements in the perceptual world. These conceptual elements are likely to bring about closure under the operations; they give to the theory a coherence or continuity which it would not otherwise have. These conceptual elements, like the irrational numbers, behave like a gelatinous material which holds in suspension the elements which correspond to the perceptual objects. The rational numbers are the numbers which correspond to observed measurements. No carpenter, engineer, or scientist ever measured a dimension or read any dial or scale except as a rational number. However, since any irrational number can be approximately arbitrarily closely by a rational number, so far as empirical evidence goes, the test of the correspondence of the Pythagorean theorem for a right triangle whose sides are each of unit length with any physical triangle of such measured dimensions is just as conclusive as if the square root of two were actually a rational number.

When a mathematical model has been selected to represent a certain class of phenomena it is likely that some interesting aspects of the physical model will not at first seem to have their images revealed in the mathematical model, and conversely. Thus mathematics and a field of application mutually support one another, at least until contradictions begin to appear. By a contradiction we mean an instance in which a theoretically computed result fails to agree with the corresponding observed result by an amount larger than the allowable (experimental) error. Since the mathematics is assumed to be consistent, and the physical system is likewise assumed to be consistent, a contradiction of this sort is accepted as conclusive evidence that the hoped-for isomorphism is not really valid. Even though the initial fit of the mathematical and physical models may appear to be very good, the normal case history is to the effect that there will come a time when the discrepancies of the two models can be no longer ignored. When this occurs, modification is called for, and an adjustment may bring about order. Unless such an adjustment is possible the given subject ceases to be one to which the given mathematics can be applied. Moreover, such a breakdown of the isomorphism throws doubt on all the happy correspondences of the past. From a "practical" standpoint this renunciation may not be disturbing but from a philosophical point of view it is; for at heart mathematics and science are as dramatic and tragic as an Ibsen play.

Newtonian dynamics and the mechanics of rigid bodies are probably the most conspicuous successes of applied mathematics. Newtonian mechanics seemed perfect for over two hundred years. It is still sufficiently good to enable you to predict the time of a total eclipse of the sun a hundred years or so hence to within an error of a fraction of a minute, and the boundaries of the path of totality to within a few city blocks. However, it is not good enough to account for an advance in the perihelion

of Mercury of about 42 seconds per century. We note that this discrepancy is one that required time in which to make its appearance; it is an accumulative difference. However, because of this property it became increasingly insistent for recognition. The easing of this contradiction is generally cited as one of the triumphs of relativity theory. Despite the contradiction mentioned, the construction engineer will continue to employ Euclidean geometry because of its relative simplicity, and not the geometry of relativity theory.

If a contradiction which arises between the mathematical and physical models can not be removed by a reasonable adjustment in one or the other or both, it may be decided that the departures, even though noticeable, are still statistically significant. Whether or not this is the case is probably largely a matter of opinion. If the departures become too great even statistics is no longer interested.

The extreme case in the other direction is when the two models fit perfectly, when there is no longer any doubt about the isomorphism. The complete establishment of the isomorphism automatically transforms the applied mathematics into pure mathematics. Some people object to the term "pure mathematics." Naturally the connotation is quite different from that in chemistry, for example. Here the term is descriptive of a lack of refinement inasmuch as no effort is made to interpret the symbols; the theory has structure but no substance. The observable world is the answer book for applied mathematics; pure mathematics has no answer book. Evidently bookkeeping is pure mathematics. A bookkeeper in a brokerage firm need not know what the symbols stand for; he merely needs to know a few simple rules of abstract arithmetic. In earlier stages theoretically mechanics was properly regarded as applied mathematics. However, this is no longer the case, for theoretically mechanics under well-stipulated laws is a deductive science and has precisely the characteristics of an abstract mathematics. Having different names for certain symbols, such as "particle" in place of "point" or "velocity vector" in place of "tangent vector," is quite analogous to substituting the appropriate words of another language for these objects. There is of course a field of applied mechanics and the mathematics which is likely to be applicable is that of theoretical mechanics. A parallel situation occurs in optics. Thus there is a mathematical subject called geometrical optics and an associated one called physical optics. It is interesting to note that the recently established Westinghouse Fellowships in Electron Optics are available only to those with specialized training in the field of physics, mathematics or electrical engineering.

A measure of the "logical" qualities of a subject is the uniformity of the results which different individuals obtain from a given initial set-up. By this test mathematics is perhaps the most logical body of knowledge in existence. I am of the opinion that one of the contributing reasons for this is the fact that the mathematician does not know what he is talking about; that is, he has no concrete interpretations for the symbols. This being the case he has no personal interest in the outcome. He is not under a certain nervous tension as may be the case when adding the bills due during the current month or when making out the income tax return. The above observation concerning the logical aspects of mathematics must not be confused with a prevalent but erroneous one, to the effect that a mathematician must be a very logical person. On the contrary, he is likely to be less logical than the average. The correct statement is: The mathematics which a mathematician does is logical. In a great deal of his work he has learned to rely upon the symbols and their admissible relations, and he is therefore handicapped when attempting to deal with situations not expressed in terms of the symbols with which he customarily works.

If a system is to be amenable to mathematical treatment it must have two properties: (1) It must be a logical system, and (2) in some sense it must be extremely simple. Hobson ("The Domain of Natural Science") writes: "Number and extension with which Arithmetic in the extended sense and geometry, are alone directly concerned, can be developed as sciences descriptive of only the most superficial aspects of the perceptual world, since they leave aside almost all the properties and qualities of perceptual things as irrelevant for the purpose of their construction, so that in these departments the process of abstraction and idealization can take gigantic strides at a very early period in their genesis."

If all the properties of an object are taken into consideration, it is clear that no observable object is simple. To achieve simplicity all properties of the object not deemed essential for the particular purpose are supposed "stripped off." To make effective progress it must be possible to isolate the system from the rest of the universe. So far as Newtonian dynamics is concerned the solar system is effectively isolated. As knowledge of such possibly isolated systems becomes better and better organized we may expect mathematics to play an increasing role in their further development. Mathematics has already established itself as being an in

portant adjunct in almost any investigation in the physical sciences. The biological sciences are entering a phase in which mathematics may prove useful, although I suspect the biologists will have to be content with statistical procedures.

When we attempt to apply mathematics to a social system, such as might appear in the subject of sociology or economics, grave difficulties arise. For such a system is not logical, and it is not simple. There is no reason to suppose that a rigorously logical structure will fit any region of human activity where events, as they appear in the time scale, have no predictable, or even expected, uniformity. Consider this question: Why is the salary of a judge of the Supreme Court not subject to Federal income tax? After you have answered this by a sequence of logical moves try another one: Why should a responsible Government sponsor a program which calls for slaughtering of pigs in Iowa, burning of wheat in Kansas, support of a subsidy for decreased agricultural production, and at the same time construct a Boulder dam, one of the reasons for such construction being to open up several hundred thousand acres of tillable land? The acts and decisions of people are very largely unpredictable, and it is this uncertainty, I believe, which almost precludes the possibility of applying mathematics, in any practical sense, to a social system.

In particular, there has been a noticeable lack of satisfactory results from attempts to apply mathematics to certain aspects of economics. I have just offered my explanation of these failures, but some other reasons have been advanced which still hold out a little hope. One of these is: there are variables present which are not even recognized, and of those variables which are admitted, we do not know how a variation of a given one will change the functional value of the function we seek to determine. This argument is based upon the tacit assumption that the mathematics is adequate and that the difficulty is due to the complexity of the situation. There is no doubt but that it is very complex. Take the simplest economic problem which you can conjure up and contrast it with the problem of formulating Newton's Law of Gravitation. In the latter case you suppose two bodies with masses $m$ and $m'$ respectively, at a distance $r$ apart supposed relatively large with respect to the maximum diameter of either body. We want a formula which gives the force $F$ of attraction between the bodies; that is, we are looking for a function of the variables $m$, $m'$ and $r$ which yields the proper functional value when numerical values are inserted for the variables. One recognizes that there must be involved a constant $k$ depending upon the units in which the quantities are measured, and that the function is probably symmetric in the variables $m$ and $m'$ and that it is properly monotonic decreasing in $r$. Naturally there are infinitely many functions with these properties. Of all the functions the desirable one, if any, is the simplest one which yields results within the tolerances allowed. One naturally tries $kmm'/r$ but that is no good. The next guess is better, for this time we take the denominator to be $r^2$ instead of $r$. The whole problem is perhaps not quite so simple as we have just indicated. However the point of emphasis here is that the problem is relatively simple in comparison with a corresponding problem dealing with any social system.

Von Neumann and Morgenstern in their amazing book, "Theory of Games and Economic Behavior," offer another reason for the failure of mathematics to achieve significant results in the economic field; namely, that the mathematics used has not been adequate to analyze such phenomena. They call attention to the fact that most of the mathematics has been developed for the purposes of physical science. The theory of the real number system, or linear continuum, then naturally occupies a conspicuous part in most of the mathematics. One of the important properties of the real number system is that it is a well-ordered set. That is, given two real numbers, $x$ and $y$ say, they satisfy one of the three order relations, $x$ is greater than $y$, equal to $y$, or less than $y$. Moreover, this relation is transitive. That is, if $x$ is greater than $y$, and $y$ is greater than $z$, then $x$ is greater than $z$. Also, if $a$ is greater than $b$, and $c$ is greater than $d$, it follows that the sum $a$ plus $c$ is greater than the sum $b$ plus $d$. This relation may, however, not hold in an economic theory. For it may be that of two possibilities, $A$ will be preferred to $B$, and of two other possibilities $C$ will be preferred to $D$, but that $A$ and $C$ will not be preferred to $B$ and $D$. Imagine the average school teacher retiring at age sixty-five. He will probably prefer a life annuity, under the relatively favorable terms which existed a few years ago, which is purchasable for twenty-five thousand dollars to a cash settlement of that amount. In the hypothetical case in which he is confronted with two such decisions he will probably elect to receive the fifty thousand dollars in one sum.

Instead of attempting to analyze economic situations, as such, Von Neumann and Morgenstern content themselves with mathematical aspects of certain games. The idea is that these games present to some extent the structure that might be expected in more serious economic "games." The book is largely given over to existence theorems, and the complexity

of the mathematics is truly prodigious. Not many persons in the world are able to write such a book, and it is my opinion that there are still fewer economists in the world who are able to read it.

It may turn out that the biologist can be of more use to the economist than the mathematician. I have a friend who is interested in correlating sunspot activity with prices of the stock market. He seemed surprised when I asked why these things should have anything to do with each other. "It's quite simple," he said, "you see, during periods of high sunspot activity people are more optimistic in their outlook than usual, and hence are inclined to take more chances."

# OBITUARY

## FLORENCE BASCOM

### 1862–1945

THE first and probably the foremost American woman geologist, Dr. Florence Bascom, died on June 18th in Williamstown, Massachusetts. She was a fellow and former vice-president of the Geological Society of America, professor emeritus of Bryn Mawr College and a retired member of the Petrological Section of the U. S. Geological Survey.

Miss Bascom was born in Williamstown in 1862, the daughter of the late John and Emma Curtiss Bascom. Her father was professor of philosophy in Williams College, and her early years were typical of the New England of her time. A strict but intellectual family life in a New England college town may have, in large measure, served to develop the integrity of thought and intellectual honesty which were notably characteristic of her in later life.

Her father later became president of Wisconsin University. Florence Bascom entered that university, graduating in 1882. Up to that time her interests had not been notably scientific. She was a brilliant student, mastering many subjects, with a keen interest in all fields of knowledge. She continued to study at the University of Wisconsin, taking an M.A. in 1884. By that time she had definitely turned to geology, especially the almost unknown field of petrography. In the eighteen eighties the microscopic study of minerals and rocks was in its infancy. Most of the pioneer work in this line was done in Germany, and the original German papers were the only descriptive literature. Those of us who are old enough to have begun our study of petrography before Rosenbusch's text-book had been translated can testify as to the difficulty of mastering the optical properties of minerals from a German description. In her case there was not even a text-book. That she did master the subject and decide to make it her specialty is an indication of her courage and of that determination which found nothing too difficult.

When Johns Hopkins University opened its Graduate School to women, Miss Bascom entered and continued her petrological studies under the late George H. Williams. Her thesis was on certain formations in the South Mountain in Maryland. These formations had previously been regarded as sediments, but her study of them under the microscope proved them to be altered volcanics. She named them "Aporhyolites," the prefix "apo" long remaining in general use for igneous rocks altered by recrystallization. Miss Bascom received her Ph.D. from Johns Hopkins in 1893. She was the first woman to receive that degree from Johns Hopkins.

For the next two years she was instructor and associate professor of geology at Ohio State University. In 1895 she went to Bryn Mawr College, and there founded the Department of Geology. It is probable that her prestige as a research scientist was responsible for this opportunity. Bryn Mawr has, from its beginning, put a high value on productive scholarship, and Miss Bascom was of great promise in that direction. There was no intention of establishing a new important scientific department. Geology was thought to be a subject that would have no wide appeal to women, and the college lacked both funds and space. Dalton Hall, the science building, had recently been completed and its three main floors were already fully occupied by the established departments of physics, chemistry and biology. A fourth floor was used for storage by these three departments. It was on this fourth floor that a small office was boarded off for Miss Bascom, and a slightly larger room for combined lecture room and laboratory. This classroom was arranged for twelve students, and that was the size that one elementary class was expected to remain.

While Miss Bascom fully agreed with the tradition of the college in regard to research, her ideas were quite different as to the importance of geology in a college. She felt that geology was the most important of the sciences, to some extent including the others, and that it was really the culmination of all science. Probably no one will ever know all the difficulties that she encountered, but little by little she achieved her purpose of making her department one of the best in the country. In 1899 she was teaching petrography, having acquired one really good petrographic microscope and an admirable collection of thin sections of minerals and rocks. In 1906 she became full professor, and had an associate who relieved her of

paleontology and stratigraphy. Throughout her thirty-three years of teaching she remained on the fourth floor of Dalton Hall, geology slowly encroaching upon the storage space of the other departments. By the time Bryn Mawr built a new science building and geology moved to adequate quarters, Miss Bascom had retired.

As a teacher Miss Bascom put the maximum of material into her courses, and she required the maximum of effort on the part of her students. Geology is a dramatic subject, and it is easy to make it so exciting that large classes result. This was not Miss Bascom's way. She had so much respect for her subject and for real scholarship that she put into her teaching that earnestness of purpose that was always characteristic of her. The result was that her elementary class was always small, never numbering more than about thirty, but her advanced classes grew. Soon graduate students were coming to her from all parts of this country and from foreign countries as well, and her students went out to all parts of the world.

In 1896 Miss Bascom was appointed assistant on the U. S. Geological Survey. She later became geologist and was assigned that section of the Piedmont that lies in Maryland, Pennsylvania and part of New Jersey. For many years she spent her summers mapping the schists and gneisses of this area, studying thin sections of the rocks in such time as she had in the winter. It is an area of great complexity which her careful study has done much to clarify. After her retirement from teaching she carried on work on the area assigned, working first at Bryn Mawr and later in Washington. It is characteristic of her that when the universal stage became an adjunct of the petrographic microscope she mastered its use and restudied many of her slides. The results of her study of this area are comprised in her part of the U. S. Geological Survey Folios, Philadelphia (1909); Trenton (1909); Elkton-Wilmington (1920); and in two Bulletins, Quakerstown-Doylestown (1931); and Honeybrook-Phoenixville (1938).

In addition to her major work, Miss Bascom wrote numerous short papers, some of them in the field of geomorphology. She was greatly interested in gravels and collected them from many places. Her interest lay in studying thin sections and in trying to trace by this means the source of the gravel. Only one joint paper resulted from this line of study. In that she traced the source of the Pensauken gravel to the quartz nodules of the Kittatinny limestone. The senior author of the paper on the Pensauken gravel was Marius R. Campbell. The paper appeared in the *American Journal of Science* in 1933. Her entire bibliography comprises about forty titles.

She was the first woman to be elected fellow of the Geological Society of America. In 1924 she became a councilor and in 1930 vice-president of that society, the only woman who has ever held these offices. She was an editor of *The American Geologist;* a member of the National Academy, of the National Research Council, of the Geophysical Union and of many other scientific societies.

Miss Bascom was the last of a brilliant family; no near relatives survive her. She will be mourned by former students in many parts of the world who will miss her ever ready counsel and advice.

IDA H. OGILVIE

## RECENT DEATHS

DR. EDWARD WILBER BERRY, since 1917 professor of paleontology at the Johns Hopkins University, dean from 1929 to 1942, died on September 20 at the age of seventy years.

DR. FREDERIC KING BUTTERS, professor of botany at the University of Minnesota, died on August 1 at the age of sixty-seven years.

DR. WILLIAM A. GROAT, until his retirement two years ago professor of clinical pathology at Syracuse University, for forty years connected with the College of Medicine, died on September 9. He was sixty-eight years old.

DR. HERMAN M. PARTRIDGE, assistant professor of chemistry and director of broadcasts at New York University, died on September 16 at the age of forty-two years.

DR. HAMILTON BRADSHAW, assistant director, retired, of the department of chemistry of E. I. du Pont de Nemours and Company, died on September 6 at the age of sixty-three years.

DR. CHARLES SPEARMAN, professor emeritus of psychology of the University of London, died on September 17 at the age of eighty-two years.

# SCIENTIFIC EVENTS

## PUBLIC LANDS CONTAINING RADIOACTIVE MINERALS

PRESIDENT TRUMAN'S order prohibiting the sale of all public lands containing radioactive minerals, reads:

By virtue of the authority vested in me as President of the United States, it is hereby ordered as follows:

(1) Subject to valid existing rights, all public lands of the United States, including Alaska, which contain

deposits of radioactive mineral substances, and all deposits of such substances, are hereby withdrawn from sale and all other forms of disposal under the public-land laws, including the mining laws, and reserved for use of the United States.

(2) So far as not in conflict with existing law, all lands in the United States, its territories or possessions, heretofore acquired by the United States which contain deposits of radioactive mineral substances owned by the United States are hereby reserved from sale, and all leases, licenses, or other authorizations of whatever kind hereafter granted to occupy or use such lands, shall reserve to the United States the right at any and all times to enter upon such lands, and mine and remove such mineral substances; and all such lands hereafter acquired by the United States shall become subject to provisions of this paragraph under their acquisition; Provided, that no reservation under this paragraph shall interfere with the use of the lands established or indicated by any Act of Congress.

## THE COORDINATING COMMITTEE OF THE UNITED NATIONS STANDARDS

WORD has been received by Herbert J. Wollner, secretary-in-charge of the New York Office of the United Nations Standards Committee, from the national standardizing bodies of China and France that they will attend the forthcoming meetings of the United Nations Standards Coordinating Committee to be held in New York during the week of October 8.

Invitations to attend the meeting have also been sent to the Standards Association of Australia, the Associacao Brasileira de Normas Tecnicas, the Canadian Standards Association, the British Standards Institution, the New Zealand Standards Institute, the South African Standards Institution and the American Standards Association. It is anticipated that representatives from practically all these countries will be in attendance.

The program of the meeting will include (1) discussion of whether the time is now ripe for setting up a permanent international standards organization; (2) a study of ways in which coordination of the standards of different countries can streamline international trade. This will be the first international meeting to be held since the United Nations Standards Coordinating Committee opened its doors a year ago to encourage cooperation between the allied belligerent countries in standardization matters as an aid to production of war supplies and equipment and also to pave the way for postwar trade.

Unhampered international trade establishes and cements friendly relations between people. One of the barriers to its fullest development arises from the differing manufacturing practices which exist in the importing and the exporting countries of the world. International questions have already arisen regarding moisture content of wool knitting yarns, radio interference, methods of testing textiles, standardization of food containers in the international shipment of relief supplies, etc.

A full program of the detailed discussions to be undertaken at the meeting will be announced at an early date. In a general way, however, it can be said that the meeting will concern itself with the immediate problem of establishing the closest practical relations between the national standardizing bodies of the countries of the world; with the providing a forum through which these bodies can harmonize their activities internationally, and finally the meeting will deal with the major problem of integrating national standards and harmonizing them for the benefit of the total economy of the world.

It is anticipated that each of the national delegations will be prepared to present its national point of view in the form of a program. It will be the endeavor of the committee to weld these into one single international program.

## PLACEMENT OF VETERANS BY THE NATIONAL ROSTER OF SCIENTIFIC AND SPECIALIZED PERSONNEL

THE National Roster has established a cooperative arrangement with both the Army and the Navy to assist professionally qualified personnel being discharged from the armed forces to obtain suitable positions in civilian life. A supply of post-card forms has been made available at the separation centers, hospitals and other discharge points of both the Army and the Navy. Every serviceman who is professionally qualified and who is passing through one of the discharge points for separation is given one of these cards if he indicates he wants assistance in locating employment. It is suggested to him that he complete and mail the card, which is already addressed and requires no postage.

When the National Roster receives one of these cards, a check is made to determine if the applicant is already registered with the National Roster. If he is not registered, appropriate documents are sent him for completion. From his Roster registration documents there is prepared a summary of his training and experience, emphasizing particularly the work he is best qualified to do.

The National Roster now has on hand a large volume of orders for technical personnel from industrial establishments, colleges and universities and non-profit research laboratories throughout the country. Additional orders of this kind are being received daily.

The summaries of the training and experience of the applicants are checked against these orders and a copy of the summary for each applicant sent, if pos-

sible, to three or four employers having vacancies on their staffs for which the applicant appears qualified. Every effort is made to refer the summary to more than one employer in order to increase the chances of the applicant's securing a position. If the employer, after examination of the summaries referred to him, is interested in any of the applicants, he proceeds to get in touch with them directly. All negotiations from that point on, such as personal interview, salary, etc., are carried on between the employer and the applicant. The Roster only asks that a report be furnished of the outcome of the negotiations.

These procedures based upon experience to date are said to be working quite satisfactorily. An increasing number of cards is now being received as the rate of demobilization advances. As more and more employers learn of the Roster, the number of job orders being received is also increasing. It is hoped that this service will be of real value in assisting former servicemen to become reestablished in civilian life.

## NEWS FROM ABROAD

DR. MARSTON T. BOGERT, president of the International Union of Chemistry, has transmitted to SCIENCE the following communications:

From Professor Dr. E. Briner, president of the Federation of Swiss Chemical Societies, School of Chemistry, Geneva, August 12, 1945.

Permit me first of all to express to you the great satisfaction I have experienced from receiving your letter of July 18th, for it is a manifestation of the resumption of the activities of the International Union of Chemistry. It reached me after some delay for it was transmitted to me at a mountain resort where I was taking a little rest after a strenuous year, because of the large number of our students. Our country has become, in effect, a land of refuge for a crowd of students who have fled the Nazi terror reigning in Germany and in the countries occupied by the Germans.

As to the International Union of Chemistry, I have been particularly happy to be of some assistance to it during these difficult years, in obtaining a liaison between the great International Chemistry Commissions. I remain naturally at its disposal whenever I can be of service to it in one way or another.

For some weeks we have had the pleasure of receiving numbers of American soldiers who have come to pass a short leave in Switzerland. We believe that they will be very happy in visiting the many beautiful places in our country. Further, for the winter semester, courses are being organized especially for American military students. They will come to spend a few months in the Swiss universities and this will prevent them from losing some of their contacts with science. At the Geneva School of Chemistry, which is the building housing the lecture halls and the laboratories of chemistry for our Faculty of Sciences, we are preparing to reserve for them the best accommodations possible.

(Signed) E. BRINER

From Professor Dr. Octave Dony-Henault, vice-president, International Union of Chemistry, 50, Rue de L'Ermitage, Brussels, Belgium. August 6, 1945.

As to Belgium, this is our present situation. As I stated to you in another letter some ten months ago we have lost, unfortunately, two of the deans of Belgian chemistry, Frederic Swartz and Leon Crismer, who both perished as a result of sickness. Frederic Swartz[1] was the president of the National Belgian Committee of Chemistry, of which our colleague, Professor Jean Timmermans, is still the secretary. The latter has just returned from England where he was throughout the war and we have just elected him a corresponding member of the Royal Academy of Belgium.

At a quite recent session we had occasion to discuss among the chemists the question which you have presented to us and I have communicated your letter to Messieurs Timmerman, Bruylants and Wuyts. It was agreed to take up the question at a special reunion of the National Committee, in order to replace the members who have disappeared and to decide how we will be able to resume our activities. Another chemist of the University of Louvain, Professor Mund, has likewise been elected to the academy and the result will be that it will be very easy for us at our monthly meetings to get together in the Class of Sciences. In any event, Mr. Timmermans, as secretary, will not fail to get in touch with you.

(Signed) OCTAVE DONY-HENAULT

Professor P. Boysen Jensen, of the University of Copenhagen, under date of September 3, wrote to Dr. Richard H. Goodwin, of Connecticut College, as follows:

Your letter was the first one to reach me from the U.S.A. and England after so many years. . . . Yes, it has been five hard years, but we are still alive, my daughter and I. Maybe you remember the Garderkaserner that is situated east of the Botanisk Have (the University Botanical Garden); it was occupied by the Germans, so the plant physiology laboratory and Professor Boysen Jensen's house were in the fire line. Especially April was filled with anxiety. We did not know if our country and Copenhagen would be burned, as so many other countries and cities. We are happy that it is over now.

If you worked in the laboratory to-day you would find it in about the same state as when you left it in 1938. We have got some more apparatus and we have continued our scientific work as well as possible.

During the war we have heard almost nothing about the plant physiological activities in the U.S.A. and

[1] Brother-in-law of the late Dr. Leo Hendrik Baekeland.

England. Sweden has now and then lent us some journals—that is all. We are therefore anxious to know what has happened and to renew our exchanges with our American friends.

Dr. Walter Landauer, of the University of Connecticut, writes:

Professor Silvio Ranzi (Instituto di Zoologia e Anatomia Comparata, Universita di Milano, Via Celoria 10, Milano, Italy), after having fled to Naples during the German occupation, has now returned to his position in Milan. Inasmuch as no American journals are as yet reaching Italy, Professor Ranzi is very anxious to receive reprints from American colleagues.

Dr. Donald P. Costello, of the University of North Carolina, writes:

Dr. Boris Ephrussi, of the marine laboratory at Roscoff, has been appointed head of a new department of genetics at the University of Paris, beginning on October 1. Plans are being formulated for developing genetic research in France, despite the fact that conditions there are still very unsettled and difficult.

An Associated Press dispatch reports that research equipment for the department of medicine of Charles University, Prague, which was almost completely removed during the German occupation, will be restored by the Rockefeller Foundation.

# SCIENTIFIC NOTES AND NEWS

THE medal of the Typhus Commission has been awarded to Dr. Francis G. Blake, dean of the Yale University School of Medicine, and to Dr. Kenneth F. Maxcy, professor of epidemiology at the School of Hygiene and Public Health of the Johns Hopkins University. The decorations were presented by Major General Norman T. Kirk, Army Surgeon General, in 1943, at the request of General of the Army Douglas MacArthur, for investigations on scrub typhus in the South Pacific.

THE Distinguished Service Medal has been awarded to Commodore William S. Parsons, who represented the Navy in the development of the atomic bomb. Distinguished Civilian Service Awards have been conferred upon Dr. Ross Gunn and Dr. Philip H. Abelson, of the U. S. Naval Research Laboratory, in recognition of their scientific contributions to the splitting of the atom. The awards were presented by Secretary of the Navy James V. Forrestal.

THE Paris Academy of Medicine held a plenary session on September 4, at which Sir Alexander Fleming, the discoverer of penicillin, was made an honorary member.

AT the presentation on October 26 to Dr. Donald Babson Keyes of the Honor Scroll of the American Institute of Chemists, Dr. H. R. Kraybill, director of research of the American Meat Institute and chairman of the Chicago section of the Institute of Chemists, will preside and will present the award. Dr. Gustav Egloff, Universal Oil Products Company, president of the Institute of Chemists, will speak on "Keyes the Man." Dr. Albert L. Elder, director of research of the Corn Products Refining Company, will speak on "Keyes and His Achievements," and Lawrence Brown, assistant director and reconversion officer of the Chemicals Bureau of the War Production Board, on "Keyes and Chemicals During World War II."

DR. E. MONROE BAILEY, chief of the department of analytical chemistry of the Connecticut Agricultural Experiment Station at New Haven for twenty-eight years, will retire on October 1. Dr. Bailey had charge of all feed and fertilizer inspection and analyses for the State, and analytical work in connection with the enforcement of State food, drug and cosmetic laws.

PROFESSOR ROGER ADAMS, head of the department of chemistry of the University of Illinois, who has been on leave of absence since 1942 as a member of the National Defense Research Committee and chairman of one of its divisions, has been given a further year's leave of absence by the University Board of Trustees. Professor William C. Rose will continue as acting head of the department of chemistry. Though Professor Adams has been on leave, he has continued to supervise the training of graduate students in research and has been directing scientific investigations of his own.

DR. WILLIAM H. SEBRELL, of the U. S. Public Health Service, acting in the capacity of nutrition consultant to the Surgeon General, has returned from a three months tour of duty in the European Theater of Operations where he acted as nutrition consultant to Major Stayer. During this period Dr. Sebrell directed the activities of the five nutrition survey teams operating in that area.

ACADEMICIAN VLADIMIR LEONTIEVICH KOMAROV, president of the Academy of Sciences of the USSR since 1936, has resigned on account of ill health. He is succeeded by Professor Sergei Ivanovich Vavilov, a well-known physicist. He is a brother of the plant geneticist Nikolai Ivanovich Vavilov, a former president of the Lenin Academy of the Agricultural Sciences.

PROFESSOR RAYMOND E. KIRK, head of the department of chemistry and dean of the Graduate School of the Polytechnic Institute of Brooklyn, has been

elected chairman of the New York Section of the American Chemical Society to take office on July 1. He succeeds Dr. Cornelia T. Snell, of Foster D. Snell, Inc., Brooklyn, consulting chemists.

COLONEL BOYD W. BARTLETT, U.S.A., has been appointed professor of chemistry and electricity at the West Point Military Academy. He will succeed Professor Chauncey L. Fenton, who has retired.

DR. ESMOND E. SNELL, formerly associate professor of chemistry and research biochemist in the Biochemical Institute of the University of Texas, has been appointed associate professor of biochemistry at the University of Wisconsin.

DR. PRESTON E. CLOUD, JR., now associate geologist with the U. S. Geological Survey, has been appointed faculty instructor in geology at Harvard University. He will take over the courses in paleontology formerly given by Professor Percy E. Raymond, who retired on August 31. Dr. Cloud is known for his work on Paleozoic Brachiopoda.

DR. KENNETH L. TURK will succeed, on October 1, Professor Frank B. Morrison, since 1927 head of the department of animal husbandry of Cornell University. Dr. Morrison will hereafter devote his full time to research.

DR. NICHOLAS U. MAYALL, who has been absent on leave for war research, has been advanced from assistant astronomer to associate astronomer at the Lick Observatory. He expects to take up his work at the observatory on October 1.

DR. BANNER BILL MORGAN has been promoted from an assistant professorship to an associate professorship and parasitologist in the department of veterinary science of the University of Wisconsin.

DR. CLAIR L. WORLEY, research microbiologist of Wyeth, Inc., Chagrin Falls, Ohio, has joined the faculty of Youngstown College, Ohio, as professor of biology.

DR. T. S. WHEELER has been appointed by the Senate of the National University of Ireland to be professor of chemistry in University College, Dublin, in succession to the late Professor T. J. Nolan.

DR. JOHN B. BUCK, assistant professor of zoology at the University of Rochester, has been appointed cytologist at the Industrial Hygiene Research Laboratory of the National Institute of Health, Bethesda, Md.

DR. A. HUGHES BRYAN has been appointed deputy director of health for the United Nations Relief and Rehabilitation Administration. He succeeds Dr. James A. Crabtree, who will return to the United States Public Health Service.

DR. SOPHIE SPITZ, contract surgeon, has been released from the Army Medical Corps and will resume her work as assistant pathologist at the New York Memorial Hospital for the Treatment of Cancer and Allied Diseases. For the past two and a half years she has been stationed at the Army Institute of Pathology, where she has served as reviewing pathologist for orthopedic as well as for tropical diseases.

DR. ISMAEL VELEZ, while on sabbatical leave of absence from the Polytechnic Institute at San German, Puerto Rico, is this year, 1945–46, working in the Institute of Tropical Agriculture, Puerto Rico, of which Dr. Carlos E. Chardon is director. He is studying weed control by means of the weed-killer 2-4 dichlorophenoxyacetic acid, under Dr. J. Van Overbeek.

DR. J. FRANKLIN FUDGE, chemist of the Agricultural and Mechanical College of Texas, succeeded Dr. G. S. Fraps, Texas State chemist and chief of the Division of Chemistry, when the latter retired on August 31 after serving since 1929.

CHARLES E. LAWALL has resigned as president of the University of Virginia. He will become engineer of coal properties for the Chesapeake & Ohio Railroad.

DR. J. P. HOLT, associate professor of physiology at the University of Louisville School of Medicine, has been appointed director of research in the medical department of the Standard Oil Company, New Jersey.

JULIE VINTER HANSEN, junior astronomer at the Lick Observatory during the war, resigned on September 1, in order to return to her position as observer at the University Observatory at Copenhagen.

GERALD LIGHTFOOT has retired as secretary of the Australian Council for Scientific and Industrial Research, a position which he has held since the inception of the council in 1926. He has been appointed a member of the council and has been succeeded as secretary by G. A. Cook.

THE annual meeting of the Association for Research in Nervous and Mental Diseases has been postponed for a year. The subject for discussion will be "Epilepsy."

THE Pacific Coast Section of the Society for Experimental Biology and Medicine recently passed the following resolutions: (1) "We deplore the campaign being waged at this time to limit biological experimentation by means of anti-vivisection legislation in state and in national legislatures." (2) "We endorse the setting up of a Bureau of Public Relations to educate the public on the issues at stake."

THE second annual research conference of the Uni-

versity of Pittsburgh on x-ray and electron diffraction will be held on Friday and Saturday, November 2 and 3. Dr. Maurice L. Huggins, of the Eastman Kodak Company, will present a paper on "The Use of Fourier Syntheses in Crystal Structure Analysis" at the Friday evening session. Representatives of the diffraction laboratories in the Pittsburgh district will present papers on Friday afternoon and Saturday morning. On Friday evening a testimonial dinner will be given in honor of Professor Wheeler P. Davey, of the Pennsylvania State College. All sessions will be held in the auditorium of the Mellon Institute for Industrial Research. Inquiries concerning details of the program and reservations for the dinner should be addressed to Dr. S. S. Sidhu, Department of Physics, University of Pittsburgh.

THE War Committee on Conventions has removed the ban on conventions, group meetings and trade, as of October 1. The restrictions were lifted on recommendation of the Office of War Mobilization and Reconversion, at whose instance they were imposed, effective on February 1, 1945. Until August 17, permission of the War Committee on Conventions was required for the holding of any meeting of non-local character or with more than fifty non-local participants. The recent liberalization increased the attendance limit to one hundred and fifty persons and permitted State-wide gatherings of any size.

NEW YORK UNIVERSITY COLLEGE OF MEDICINE has received a three-year grant of $150,000 from the W. K. Kellogg Foundation to help to defray the cost of its program for returning medical veterans and to aid in expanding its permanent program of postgraduate medical education. Twelve hundred graduates have been serving in the armed forces—New York University anticipates that four fifths, or some nine hundred and sixty, of its graduates on active duty in the armed forces will participate in some type of postwar medical instruction.

THE Lewis Cass Ledyard, Jr. Fellowship, of the New York Hospital, of which the income, amounting to approximately $4,000, is awarded annually to an investigator in the fields of medicine and surgery, or in any closely related field, will be applied as follows: $3,000 as a stipend and, approximately, $1,000 for supplies or expenses of the research. Preference will be given to younger applicants who are graduates in medicine, and who have demonstrated fitness to carry on original research of high order. Research work is to be carried on at the New York Hospital and Cornell University Medical College. Applications for the fellowship, of which one or more may be granted, will be received at any time before November 15. They should be addressed to The Committee of the Lewis Cass Ledyard, Jr. Fellowship, The Society of The New York Hospital, 525 East 68th Street, New York 21, N. Y.

THE Josiah Macy Jr. Foundation of New York will receive the residuary estate of the late Mrs. Kate Macy Ladd, of Somerville, N. J., who died on August 27. Further provision for the Macy Foundation is contained in a clause in her will creating a fund of $2,500,000 and stipulating that the income "shall be used to initiate, stimulate, develop and support scientific investigations of the fundamental aspects of health, sickness and the relief of suffering."

BY the will of the late Professor Benjamin Warner Snow, who died in 1928, for more than thirty years professor of physics at the University of Wisconsin, the entire estate has been held in trust since 1928 with its income going to two relatives during their lifetime. Upon their death the estate is now divided, two fifths going to the university, two fifths to the Wisconsin Alumni Research Foundation and one fifth to an Eastern girl's school in which a sister taught. The two fifths going to the regents, amounting to $20,437, is to constitute a "living memorial" to be known as the Agnes Butler Snow Fund in memory of the wife of Dr. Snow, who died before him. It is to be used as a revolving loan fund for students. The money going to the Wisconsin Alumni Research Foundation will be used for the encouragement of research work in the department of physics.

AN Associated Press dispatch reports that the apportionment of $880,000 among forty-seven states for restoration and development of wildlife resources for the twelve months ending next June 30 has been announced by Secretary of the Interior Harold Ickes. States and territories participating in the program are required to contribute 25 per cent. of the cost of the work. The Federal allotments this year are $73,000 above last year's apportionment. The 25 per cent. additional State contribution will make the sum of $1,180,000 available. Alaska receives an additional $12,000, Hawaii $5,000 and Puerto Rico $3,000. The appropriation for administrative expenses is $100,000. A grant of $51,202 to the State of Michigan is the largest this year, followed by Texas with $45,430, and New York with $41,621. Connecticut receives $5,000 and New Jersey $8,075.

THE will of the late Dr. Hugh Hampton Young, of the Johns Hopkins Medical School, according to an Associated Press dispatch, bequeaths 261 milligrams of radium, valued at $25,000, to the Johns Hopkins Hospital.

# SPECIAL ARTICLES

## ROLE OF UNSATURATED FATTY ACIDS IN CHANGES OF ADIPOSE AND DENTAL TISSUES IN VITAMIN E DEFICIENCY[1, 2]

In vitamin E-deficient rats the yellow-brown discoloration of adipose tissue depends upon the presence of dietary cod liver oil,[3,4] and the depigmentation of incisor enamel, upon dietary fats.[4,5] Peroxidation of the body fat precedes and parallels discoloration of the adipose tissue, the pigment of which shows chemical properties similar to those exhibited by pigment formed in experimental liver cirrhosis.[6] Histologically this adipose tissue reveals all globules which appear similar to, if not identical with, the pigment in other tissues of the same animals.[7] The possibility that highly unsaturated fatty acids might be responsible for these abnormal changes was tested in the following experiments.

First, the effects of fatty acids and the non-saponifiable fraction of cod liver oil were compared.[8] Two female albino rats were mated with normal males and maintained on a stock diet until delivery. Then, one female with her young (Group 1) was maintained for a 41-day period on a vitamin E-deficient diet in which the fatty acids obtained from an equivalent of 20 per cent. of cod liver oil were incorporated.[9] The other female with her young (Group 2) was reared on the vitamin E-deficient diet in which was incorporated the non-saponifiable fraction obtained from the same amount of oil.[10] Since changes in the adipose and dental tissues appeared in animals receiving the fatty acids (Group 1), the effects of three different fatty acid fractions were compared. Low, middle and highly unsaturated fractions were obtained by the procedure of Brown and Stoner[11,12] and given in vitamin E-deficient diets in amounts corresponding to that contained in 20 per cent. cod liver oil. Seven normal pregnant females were divided into 3 groups and from the time of delivery reared on experimental diets as follows: Two females with their young (Group 3) were given the low unsaturated fraction; one female with her young (Group 4) was fed the middle unsaturated fraction, and 4 females with their young (Group 5) the highly unsaturated fraction. Peroxide values were determined, and the intensity of the incisor pigment was recorded. Individual experimental results from the offspring of each group are presented in Table 1.

TABLE 1

| Group no. | Days on experiment from birth | Peroxide value milliequivalents per 1000 gm* | Color of adipose tissue | Dental pigment† | Fraction of cod liver oil in per cent. of diet, equivalent to 20 per cent. cod liver oil |
|---|---|---|---|---|---|
| 1 | 8 | | 0 | | Fatty acids, total, 19.0 |
| " | 16 | | 0 | 0/0 | " " " " |
| " | 22 | | 0 | 0/0 | " " " " |
| " | 28 | 0 | 0 | 0/0 | " " " " |
| " | 38 | 234 | +++ | 0/0 | " " " " |
| " | 41 | 184 | +++ | 0/0 | " " " " |
| " | 41 | 26 | ++ | 0/0 | " " " " |
| 2 | 8 | | 0 | | Non-saponifiable 0.28 |
| " | 16 | | 0 | | " " " |
| " | 22 | | 0 | | " " " |
| " | 28 | | 0 | 7/4 | " " " |
| " | 38 | 0 | 0 | 8/5 | " " " |
| " | 41 | 0 | 0 | 9/4 | " " " |
| 3 | 10 | | | | Fatty acid fract. 1 2.9 |
| " | 21 | | 0 | | " " " " " |
| " | 27 | 0 | 0 | 7/3 | " " " " " |
| " | 38 | 0 | 0 | 8/6 | " " " " " |
| " | 48 | 0 | 0 | 10/7 | " " " " " |
| " | 58 | 0 | 0 | 10/6 | " " " " " |
| 4 | 10 | | 0 | | Fatty acid fract. 2 10.1 |
| " | 21 | | 0 | | " " " " " |
| " | 27 | 0 | 0 | 1/0 | " " " " " |
| " | 38 | 9.9 | 0 | 5/3 | " " " " " |
| " | 48 | 0 | 0 | 7/4 | " " " " " |
| " | 59 | 0 | 0 | 6/4 | " " " " " |
| " | 75 | 0 | 0 | 7/4 | " " " " " |
| 5 | 10 | | 0 | | Fatty acid fract. 3 6.0 |
| " | 21 | | 0 | | " " " " " |
| " | 27 | | 0 | 0/0 | " " " " " |
| " | 33 | 100 | + | 2/2 | " " " " " |
| " | 42 | 94 | ++ | 3/2 | " " " " " |
| " | 44 | 152 | +++ | 0/2 | " " " " " |
| " | 46 | 281 | +++ | 0/3 | " " " " " |

* Because of the scarcity of adipose tissue during the first 3 or 4 weeks of life, peroxide values were not determined during these periods.

† First figures indicate intensity of pigment in maxillary incisors; second figures refer to pigment of mandibular incisors.

[1] From the Departments of Biochemistry and Anatomy and Division of Dental Research.

[2] Aided by grants from Wyeth Incorporated of Philadelphia and the Eastman Dental Dispensary of Rochester.

[3] H. Dam, *Jour. Nutrition*, 27: 193, 1944.

[4] H. Granados and H. Dam, SCIENCE, 101: 250, 1945.

[5] *Idem, Proc. Soc. Exp. Biol. and Med.*, 59: 295, 1945.

[6] *Idem, Acta Physiologica Scandinavica.* In press.

[7] H. Dam and K. E. Mason, *Federation Proc.*, 4: 153, 1945.

[8] The cod liver oil was saponified at room temperature by the usual procedure, using ether, KOH and methanol, dilution and removal of the non-saponifiable by shaking with ether many times. The fatty acids were obtained by further dilution of the soap solution, acidification with HCl and shaking with ether. Both fractions were rinsed with water, dried with $Na_2SO_4$, evaporated and stored *in vacuo* at low temperature.

[9] Sucrose, 45 gm; casein, alcohol-extracted, 20 gm; dried yeast, ether-extracted, 10 gm; salt mixture no. 2, U.S.P., 5 gm; tetrasodium salt of 2-methyl-1-4-naphthohydroquinone diphosphoric acid, 1 mg; vitamins A and D in oleic acid, 2 drops weekly per animal; fatty acids from cod liver oil, 23.6 gm, added to 100 gm of mixture of the preceding substances.

[10] The same basic diet as above with 65 gm of sucrose instead of 45 gm. To 100 gm of this diet was added 0.28 gm of the non-saponifiable fraction of cod liver oil.

[11] J. B. Brown and G. Stoner, *Jour. Am. Chem. Soc.*, 59: 3, 1937.

[12] The fractions were characterized as follows: Fraction 1 crystallized from a 10 per cent. acetone solution at minus 20° C, solid at room temperature, iodine value 13.4, amount 15 per cent. of total fatty acids. Fraction 2 crystalized from the filtrate of fraction 1 at minus 75° C, light yellow oil at room temperature, i.v. 99.4, amount 53 per cent. of total fatty acids. Fraction 3 remained in solution at minus 75° C, light yellow oil at room temperature, i.v. 283, amount 32 per cent. of total fatty acids.

Group 1 exhibited considerable peroxidation and marked brown discoloration of the adipose tissue, changes which were accompanied by inhibition of enamel pigment deposition. The non-saponifiable fraction (Group 2) totally failed to produce such changes. There was no essential difference in the growth curves of the two groups, although both were somewhat subnormal.

Growth in Groups 3 and 4 was essentially normal, in contrast to the marked retardation of growth in Group 5. All offspring in this group died between 10 and 46 days of age following the development of anemia and diarrhea. This is interpreted as a toxic manifestation of the highly unsaturated fraction when given separately. The fact that animals receiving the highly unsaturated fraction (Group 5) developed marked fat peroxidation and discoloration about the same time as those receiving the total fatty acid fraction (Group 1) leaves no doubt that the highly unsaturated fatty acids are responsible for these changes. In Group 4 (middle unsaturated fraction) only one animal showed low fat peroxidation without discoloration at the time marked peroxidation and discoloration appeared in Groups 1 and 5. These changes appeared simultaneously with the rapid increase in fat deposition which was apparent at the beginning of the second month of life.

The deposition of the dental pigment took place at a normal rate in Group 3, whereas in Group 4 the deposition of the pigment was slower and did not reach the same intensity as compared with that of Group 3. This could be interpreted as a slight inhibition of the full development of the pigment due to the middle unsaturated acids or more likely to a small amount of highly unsaturated acids in the middle fraction. In Group 5 the inhibition of the pigment deposition was not so complete as that in Group 1, which received the total acids, for there was a slight and retarded deposition of pigment from the 33rd day to the 42nd, at which time the pigment disappeared completely from the upper incisors. The mandibular incisors of the animals which reached the 46th day of age were still slightly pigmented, a fact which confirms previous observations of a prolonged ability of the mandibular enamel organ to deposit the pigment.[4,13] This experiment demonstrates that the highly unsaturated fatty acids are responsible for the enamel depigmentation. Qualitative differences in the fatty acids of different fats, namely cod liver oil and lard, may account for the fact that both fats produce enamel depigmentation but only cod liver oil causes discoloration of the adipose tissue.[5] The question whether the lack of the antioxidant effect of vitamin E is responsible not only for the peroxidation and discoloration of fat but also for the dental depigmentation is still not clear.

Our examination of the chemical nature of the enamel pigment has eliminated the possibility of its being a lipochrome, porphyrin or melanin. It does not fluoresce and contains iron in the ferric form, which dissolves readily in 10 per cent. HCl. When exposed to a weaker acid (2 per cent. HCl) the pigmented layer comes off as a finely granular and fibrous film or layer. Incineration of the tooth in a gas flame separates the enamel from the dentin and leaves the pigmented layer a black color. After burning away the carbon with ammonium nitrate the yellow-brown color of the outer surface of the ashes from the enamel reappears, indicating that inorganic iron alone accounts for the total color of the pigment, which in the intact tooth appears to be embedded in or loosely combined with an organic matrix. Depigmented enamel of vitamin E-deficient rats failed to give reactions for iron with potassium ferro- or ferric-cyanide; when subjected to incineration it developed only a slight gray color, which turned again white after burning away the carbon with ammonium nitrate. Exposure of depigmented teeth to 2 per cent. HCl resulted in the splitting off of a much thinner, less compact and colorless film from the outer surface of the enamel. It is, therefore, also demonstrated that the highly unsaturated fatty acids in absence of vitamin E act on the enamel organ in such a way as to inhibit the deposition of the normal iron-containing layer, resulting in white appearance of the enamel surface.

HENRIK DAM
HUMBERTO GRANADOS
UNIVERSITY OF ROCHESTER SCHOOL OF MEDICINE AND DENTISTRY

[13] H. Granados, K. E. Mason and H. Dam, *Jour. Dental Research* (Proc. 23rd general meeting International Assoc. for Dental Research), 1945. In press.

## ARTERIAL ANASTOMOSIS IN DOGS EMPLOYING VEIN GRAFTS FROM CHICKENS AND TURKEYS

As a part of extended studies directed towards devising a ready source of veins for arterial replacement in animals and humans, vein grafts from young healthy chickens and turkeys were transplanted to bridge defects in the arteries of dogs. These experiments were planned on the basis of the findings of Copley that chicken thromboplastin prepared from brain and skin is ineffective or only slightly effective in activating thrombin in recalcified oxalate plasma of mammals.[1] We have since found that chicken thromboplastin as contained in vein juice is effective with whole dog's blood in arterial segments *in vivo* for the production of coagulation thrombosis.[2] Since

[1] A. L. Copley, *Am. Jour. Physiol.*, 137: 178–186, 1942.
[2] A. L. Copley and P. L. Stefko. To be published.

our experiments in utilizing vein segments from a living, heterologous source of a lower class exhibited unexpected results, they are being reported.

Chickens weighing 2.2 to 3.6 kgm were anesthetized by intraperitoneal injection of 2 cc Veterinary Nembutal—Abbott (sodium pentobarbital-alcohol mixture); turkeys, weighing 5 to 9 kgm, were injected intraperitoneally with 0.45 cc Veterinary Nembutal per kgm. After securing the fowl to the operating table, the neck was plucked, shaved and the skin prepared with a disinfectant. Following sterile draping of the neck, the midportion was exposed. Then the right jugular vein was excised following ligation with fine silk of venous branches, usually from 7 to 15 in number. The vein segment was irrigated thoroughly with physiologic saline, sometimes containing heparin.

The dogs used were healthy mongrels weighing from 15 to 25 kgm. They were anesthetized by intravenous injection of 0.45 cc Veterinary Nembutal per kgm. The femoral and carotid arteries of the dogs—in one case the aorta—were severed and bridged with the fowl's vein, using the one-tube and two-tube non-suture methods of Blakemore, Lord and Stefko.[3] Presumptive patency or occlusion was detected by palpation[3] of the vessel distal to the graft on various days following operation. Conclusive evidence was obtained by exploratory operation which terminated the experiment.

In Table 1 a brief summary of our findings is presented. In 37 heteroplastic grafts, 9 anastomoses were patent upon exploratory operation after 2 to 12 days, while partial or complete occlusion occurred in 24 instances and disappearance of the graft in 4 cases. Sloughing of the graft from one or both arterial ends was observed in 7 instances, 6 being associated with thrombosis, and one with disappearance of the graft. These results are significant, as in only a small number (10 out of 37 transplants) either sloughing or disappearance of the graft occurred. Thrombosis was observed only after several days of presumptive patency.

TABLE 1

SUMMARY OF EXPLORATORY FINDINGS OF VEIN TRANSPLANTS FROM CHICKENS AND TURKEYS IN THIRTY-SEVEN ARTERIAL ANASTOMOSES IN DOGS

| Exploratory finding | Artery of dog | Jugular vein of fowl | Number of transplants | Day of exploration |
|---|---|---|---|---|
| Patency | Femoral | Chicken | 5 | 2,6,7,8,12 |
| | Carotid | " | 3 | 2,4,5 |
| | Aorta | Turkey | 1 | 6 |
| Occlusion (partial or complete) | Femoral | Chicken | 11 | 5,7,7,7,9,10,12,14, 14,14,18 |
| | Carotid | " | 8 | 2,5,5,6,6,8,10,67 |
| | " | Turkey | 5 | 5,5,6,10,14 |
| Slough from arterial end(s)* | Femoral | Chicken | 4 | 7,8,12,14 |
| | Carotid | " | 2 | 10,67 |
| | " | Turkey | 1 | 14 |
| Disappearance of graft | Femoral | Chicken | 4 | 8,14,20,71 |

* The 7 transplants are recorded twice, since in 6 cases sloughing occurred with occlusion and in 1 case with disappearance of the graft.

Bacterial cultures of the vein segment made immediately after removal from the fowl and of the anastomotic site in the dog during the original operation were negative. All cultures of the vein graft, the anastomotic site and the thrombus made after exploratory operation showed bacterial contamination. It is quite possible that thrombosis in the majority of anastomoses was enhanced because of bacterial influences, and that the few cases of disappearance of the vein graft may also have been effected by bacteria. The precaution of employing aseptic technique may not be sufficient because of the common occurrence of transient bacteriaemias in animals in the absence of a traumatic lesion. This problem has been discussed by Haines.[4] It is possible that the infection of our vein transplants may have resulted from such a bacteriaemia.

In spite of the generally accepted contention that heterotransplants can not be expected to survive, the period of continued function of these transplants compares favorably with the work on autotransplants in dogs by Blakemore, Lord and Stefko.[3] These authors in 25 arterial anastomoses found 12 to be patent and 13 to have complete or partial occlusion on final exploration 2 to 69 days later. Further experimentation on heterotransplants in animals should be made before vein transplantation from the fowl to the human being can be considered. Such experimental work should include the combined use of sulfonamides or penicillin with heparin or other anticoagulants.

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[3] A. H. Blakemore, J. W. Lord, Jr. and P. L. Stefko, *Surgery*, 12: 488–508, 1942.

## THE EFFECT OF PENICILLIN IN EXPERIMENTAL RABBIT SYPHILIS[1, 2, 3]

IN the November 3, 1944, issue of SCIENCE[4] I presented experiments dealing with the therapeutic effect of penicillin sodium dissolved in water and the same substance suspended in peanut oil. At that time my

[4] R. B. Haines, "Microbiology in the Preservation of Animal Tissues." Food Investigation, Special Report No. 45. London, His Majesty's Stationery Office, 1937.

[5] At present: Department of Biology, New York University.

observations covered a period of 42 days. My records showed the disappearance time of *Spirochaeta pallida* under the influence of penicillin, as well as the healing period required for the testicular lesions. It is well known that normal testicles following antisyphilitic therapy do not constitute reliable evidence of the animal's cure. An additional period of 3 to 4 months' observation after the testicles become normal again is necessary to ascertain the fact of cure. At that time the popliteal lymph nodes are removed from the rabbits and tested for spirochetes by means of their intratesticular transfer into a healthy rabbit, which in turn is observed for 3 months to note evidence of testicular infection.

In this paper I am offering the final results obtained by removing the popliteal lymph nodes 100 to 115 days after the testicles of penicillin-treated rabbits became normal. As stated in my original paper,[4] one syphilitic rabbit received intramuscularly 2,500 Oxford units in aqueous solution, twice a day for 8 consecutive days—a total of 40,000 Oxford units per kilogram body weight. The popliteal lymph node transfer test proved negative and thus indicated cure. The other two syphilitic rabbits were each treated by intramuscular injections of 5,000 Oxford units of penicillin in oil suspension, once a day for 8 consecutive days—again a total of 40,000 units per kilogram body weight. The popliteal lymph node transfers also gave negative results or cure.

Additional experiments, conducted subsequent to our publication, consisted of the treatment with penicillin sodium of 3 syphilitic rabbits. One was given 3,300 units of penicillin sodium in aqueous solution three times daily, *i.e.*, 9,900 units per kilogram body weight per day, for 8 consecutive days. The total penicillin administered in this case comprised 79,200 units (about twice the amount given to the first animal treated with aqueous solution, as described in the previous publication). The result of the popliteal lymph node transfer was negative, indicating cure. Although in both cases cure resulted (negative popliteal lymph nodes), the record shows that the lesions in the animal treated with the higher dosage were freed of spirochetes and healed in a shorter time.

Two more syphilitic rabbits received twice daily 5,000 units per kilogram body weight, of penicillin sodium in oil suspension, *i.e.*, 10,000 units per day for 8 days consecutively. Each animal was given a total of 80,000 units. The syphilitic animals were cured (negative popliteal lymph nodes). Again with the double dose the curative effect was more rapid. The spirochetes disappeared more quickly from the testicular lesions, and the lesions returned to normal sooner than with the smaller dosage.

From my experiments, one may infer that syphilitic rabbits which received 40,000 Oxford units per kilogram body weight in a period of 8 days, whether in aqueous solution or in oil suspension, were cured by every accepted standard of cure for rabbit syphilis. Translated into a treatment schedule for a patient weighing 60 kilograms, the total dose for the patient should be 2,400,000 units. One ought to keep in mind, moreover, that the animals getting twice the dosage used in the original experiments, namely, a total of 80,000 units per kilogram body weight, were not only cured but were cleared of lesions faster. A somewhat more rapid curative effect was noted with penicillin in oil suspension. Since the double dose of penicillin in oil suspension was 80,000 per kilogram body weight, it suggested that total treatment for a patient weighing 60 kilograms should be 4,800,000 units.

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## NON-TOXICITY OF DDT ON CELLS IN CULTURES

IN an attempt to find a standard cell system for studying the effects of DDT (2,2 bis (p-chlorophenyl)-1,1,1-trichloroethane) a number of experiments were performed with cultured tissues. The negative results obtained are presented here briefly.

### HANGING DROP CULTURES

A small drop of a saturated alcoholic solution of DDT was allowed to dry on a coverglass. Hanging drop cultures of heart and intestine from 7- to 8-day chick embryos and brain and spleen from a 1-day rat were set up in different combinations of Locke solution, chicken plasma, chick embryo extract and human placental serum, so as to include the dry DDT which remained stuck to the coverglass. The cytology and migration of fibroblasts, entoderm and macrophages were not appreciably different from the control cultures without the DDT during a period of 3 days to one week. Fibroblast mitoses were about as in the controls.

A similar series of cultures of the intestine from 8-day chick embryos and brain and spleen from a 1-day rat, in which saturated DDT in acetone was dried on the coverglass before the cultures were made, were set up in different media. There were no appreciable differences between their outgrowths and those in control cultures. Living fibroblasts as they moved about in the cultures sometimes touched or even migrated over DDT crystals without any appreciable injury to themselves during a period of several days.

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[1] From the Dermatological Research Laboratories, Philadelphia, Division of Abbott Laboratories, North Chicago, Illinois.

[2] The author wishes to acknowledge with thanks the cooperation of Dr. Herman Beerman, University of Pennsylvania.

[3] Dr. Raiziss died on July 16.

[4] George W. Raiziss, SCIENCE, 100: 412, November 3, 1944.

After drying on the coverglass, the DDT is only slightly soluble in water, much less than 1 part to 1,000,000 parts. Its solubility in the culture medium at body temperature is unknown but presumably the medium became saturated in the course of a few hours at 98° F.

Other combinations were tried, such as adding DDT-acetone solution to the Locke solution, and adding small fragments of cockroach chitin to some drops.

Under the conditions of these experiments the DDT had no appreciable effect on cytological characteristics of fibroblasts, macrophages and entodermal cells even when such cells were in actual contact with DDT crystals.

### Prolonged Exposure of Cells to a Weak Solution of DDT in Roller Tube Cultures

Four series consisting of 15 roller tube cultures with heart, liver, kidney, stomach, intestine, skeletal muscle, brain and spinal cord in each tube were set up in a standard medium. The clot consisted of 1 drop of chicken plasma plus 1 drop of chick embryo extract. After clotting, a supernatant fluid (7 drops Locke solution plus 5 drops human placental serum plus 1 drop of chick embryo extract) was added.

Enough crystals of DDT were then added to all but the control tubes to get a saturated solution with many crystals left over. The crystals floated around in the medium and frequently landed on the migratory zone. The supernatant was changed every 2 or 3 days and fresh crystals added each time.

The tissues were cultured for 10 to 21 days. The outgrowths usually had many mitotic fibroblasts and more or less abundant outgrowths of fibroblasts, macrophages, entoderm, liver cells, kidney epithelium, nerve fibers and muscle fibers.

They were like the controls and there was no indication that the weak solution of DDT or solid particles of it had any effect on the cells.

### Short Exposure of Cells to Concentrated DDT Emulsion in Roller Tube Cultures

In an attempt to circumvent questions arising from the low solubility and questionable penetration from solid or colloidal DDT, a quick-killing emulsion was tried. This emulsion contained 1 per cent. DDT, 9 per cent. olive oil, 1 per cent. gum arabic and 90 per cent. saline. Intracardiac injections of ½ cc of the 1 per cent. DDT emulsion produced symptoms in a few minutes and killed mice in 45 minutes to 76 hours. This emulsion was not sterile, and the contamination it introduced into the tube cultures usually forced termination to explants at the end of 24 hours. However, since the emulsion can kill an intact animal in a few hours, it seems logical that if there were any visible effect on cultured cells it should be visible within this period.

A tube of 9-day chick embryo tissues (heart, kidney, stomach, intestine, liver, muscle) was set up in the standard medium. One drop of the DDT emulsion was added; this gives a relatively high concentration, approximately 0.06 per cent. of DDT. At twenty-four hours there were outgrowths of fibroblasts, macrophages, entoderm, liver cells and kidney epithelium. These cells were in good condition. The next day the infection had increased and the tube was discarded.

To two 43-hour control tube cultures that had good outgrowths of nerve fibers, entoderm, fibroblasts, macrophages and kidney epithelium and fibroblast mitoses, one drop of the 1 per cent. DDT emulsion was added. Four and a half hours later the cells, including the nerve fibers, were in good condition and there were fibroblast mitoses. The next day the tubes had muscle fibers, nerve fibers, fibroblasts, macrophages, entoderm and kidney epithelium, all in good condition, and fibroblast mitoses. A day later the badly infected tubes were discarded.

A tube containing a number of liver explants from a 9-day chick embryo was set up in the usual medium. On the fourth day most of the explants showed outgrowths of liver cells, macrophages and fibroblasts. Mitoses of the latter were common. One drop of DDT emulsion was added to this culture. The next day the liver cells, macrophages and fibroblasts seemed to be in good condition and mitoses of the latter were common. The DDT had not produced any noticeable harm to the liver cells. All the cells were still in good condition the next day.

No DDT crystals were seen in any of the tubes, the emulsion appeared to dilute satisfactorily in the culture media used.

In some respects it may seem peculiar that we were unable to affect the growth of various cells in culture when it is easy to kill mammals by the injection of emulsions or application of solutions of DDT. We do not know the explanation of this difference between intact animals and their cells *in vitro*. Any of several factors might be involved. Cultured cells are a vastly simpler system, not dependent on the complex integration of an intact animal. Cultured cells are also supplied at all times with excess of nutrients and oxygen and with full opportunity to dispose of metabolites.

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# SCIENTIFIC APPARATUS AND LABORATORY METHODS

## IMPROVEMENT IN KEEPING QUALITY OF SUCCULENT PLANTS AND CUT FLOWERS BY TREATMENT UNDER WATER IN PARTIAL VACUUM[1]

SUCCULENT plants wilt rapidly when cut and exposed to hot, dry conditions. This is also true of cut flowers when left out of water for even short periods. A method has been found which will lengthen from 4 to 36 hours the period during which succulent plants and cut flowers may be kept in a fresh turgid condition.

Initial trials were made with sixty tomato plants (*Lycopersicum esculentum*), six inches tall, which were selected for uniformity. Thirty plants were placed in water (60 degrees F) in a 200-mm glass desiccator fitted with ground stopcock. A light weight was placed on the plants to keep them submerged, and the air in the desiccator was evacuated by means of a water pump to a pressure of approximately 30 pounds per square inch for 20 minutes. During this period, air bubbles streamed from the plants. When the vigorous escape of air had ceased, the water pump was turned off and the pressure brought gradually (10 minutes) to atmospheric pressure. In this way, air in the plants was replaced with water.

The treated tomato plants were heavy and had a dark green, translucent, water-soaked appearance which disappeared after two hours. They were placed in a chamber, with both roots and tops exposed to the air, at a temperature of 95 degrees F and a relative humidity of 20. Check plants in water were placed in the chamber along with the treated plants. After 5 minutes the untreated plants showed wilting, and after 30 minutes they were badly wilted. The vacuum-treated plants showed wilting only after 4 hours' exposure, and only half were badly wilted in 7 hours. After 7 hours' exposure, all the plants were placed with their roots in water. Twenty-six of the vacuum-treated plants regained turgidity, and four recovered partially. Of the untreated plants, 26 died and 4 recovered partially.

Similar results were obtained with cut flowers. Twelve Narcissus flowers (*Narcissus poeticus* and *N. maximus*) with stems 6 inches long were placed under water in the desiccator and the air evacuated as previously described. At 11 A.M., the 12 treated flowers, together with 12 untreated flowers, were placed in direct sunlight, with an air temperature of 80 degrees F, in order to provide severe conditions. The untreated flowers were badly wilted after 30 minutes, and after 5 hours the petals were dry and crisp. The vacuum-treated flowers were still turgid and in excellent condition at 5 P.M., or 6 hours after treatment. They were then brought into a warm room (80 degrees F) and kept on a laboratory desk over night. By 8 A.M., 21 hours after treatment, they were showing signs of wilting and by 5 P.M., 30 hours after treatment, they were all badly wilted.

Twelve trillium flowers (*Trillium grandiflorum*) were given similar treatment. Six of the treated flowers and six of the untreated ones were stood in water, and compared with six treated and six untreated which were exposed on a laboratory desk. The exposed flowers which had not been vacuum-treated were badly wilted within 1 hour, whereas those which had received the vacuum treatment began to wilt only after 6 hours. Of the flowers which were stood in water, the vacuum-treated ones remained in a fresh condition for 5 days, or 2 days longer than the untreated. The water-soaked appearance of vacuum-treated flowers was lost within 2 hours when flowers were exposed on the table, but not until 4 to 5 hours when placed with their stems in water.

Perhaps the most striking results were obtained with lilacs (*Syringa vulgaris*). Branches, leaves and flowers were vacuum-treated, as previously described. Some of both treated and untreated branches were then placed immediately in water, and others were left exposed out of water on a laboratory table at 60 to 70 degrees F.

Untreated flowers that lay exposed were badly wilted within 8 hours, while treated flowers similarly exposed remained in a fresh, turgid condition 4 to 8 hours longer. Branches which were placed in water immediately after treatment remained fresh and in good condition for 5 days, whereas untreated branches similarly placed in water showed wilting within 2 days and were badly wilted in 3 days. The water-soaked appearance disappeared in an hour or two and the flowers were in excellent condition.

Conflicting results were secured with commercial roses. In some instances the vacuum-treated flowers became brown and the petals dropped sooner than on untreated plants. On the other hand, on two occasions very favorable results were secured. Cut hybrid tea roses in the loose bud stage with 10-inch stems were vacuum-treated and left exposed on the laboratory table at 80 degrees F. Untreated roses were similarly exposed, for comparison. Those which were not vacuum-treated became wilted within 4 hours, while treated ones remained turgid for 9 to 12 hours or 5 to 8 hours longer. Flowers which were placed in water after treatment remained in the loose bud stage for 6 days, whereas the control flowers were fully opened after 2 hours and were badly wilted within 3 days.

[1] Journal Article No. 641 of the N. Y. State Agricultural Experiment Station.

The control plants also showed "blueing" of the petals after 2 days, in contrast to the relatively unchanged shade of the treated flowers. The treated flowers remained in the loose bud stage for 6 days and, although not wilted appreciably by this time, showed browning of the bases and margins of the petals. Some of the fragrance was lost as a result of treatments.

Azalea, grape hyacinth, iris, carnation and *Spirea Vanhouttei* were also treated, but the results were not outstanding.

As Table 1 indicates, there is a large increase in

TABLE 1

WEIGHT OF CUT FLOWERS BEFORE AND AFTER SUBMERGENCE IN WATER FOR 20 MINUTES IN PARTIAL VACUUM

| Material | Weight (grams) | |
|---|---|---|
| | Before treatment | After treatment |
| Azalea | 6.00 | 16.2 |
| Carnation | 25.0 | 42.0 |
| Grape Hyacinth (*Muscari botryoides*) | 14.1 | 25.0 |
| Iris | 6.6 | 12.6 |
| Lilac (*Syringa vulgaris*) | 130.8 | 180.0 |
| *Narcissus maximus* | 18.3 | 21.3 |
| Rose (Hybrid Tea) | 75.1 | 109.5 |
| *Rosa Hugonis* | 21.1 | 40.1 |
| *Spirea Vanhouttei* | 60.0 | 133.8 |
| Tulip (*Tulipa Gesneriana*) | 43.0 | 58.0 |

weight following treatment. In some cases it is more than double, depending on the material. During treatment, tissues can be observed to become water-soaked and translucent. This condition disappears rapidly in some plants, as in lilacs, but more slowly in others. Since some plants are capable of taking in more water and holding it longer than others, each kind responds differently to treatment. In general, the best results were obtained with plant materials which have large leaves and stems and large inferior ovaries, capable of serving as reservoirs.

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## MODIFIED METHOD OF EXTRACTING CHOLESTEROL*

MANY methods of extracting cholesterol from blood have been devised and most of the methods used for extraction from liver are based on those used for blood. The most common method used is that of Bloor,[1] which involves saponification. An interfering yellow color which reduces the accuracy of the Leibermann-Burchard determination is produced, which may be reduced by absence of heat[2] or the use of a red filter.[3] Ireland[4] found that the use of a red filter did not eliminate interference and devised a new method of extraction. Schoenheimer and Sperry[5] purified the cholesterol extract by precipitation with digitonin. Foldes[6] modified the digitonin precipitation method in order to eliminate the interference of bile. Noyons[7] using a method similar to Bloor's[1] found that saponification gave consistent but lower values than extraction without saponification. Teeri[8] states that extraction without saponification produced values 25 per cent. higher than extraction with saponification. Gershberg and Forbes[9] devised an acetone and alcohol extraction method with saponification for determining cholesterol content of blood.

Most of the above methods are time-consuming and many do not give reproducible results. Therefore, a new method has been devised which reduces time and gives consistent results. The method is as follows: The liver is ground thoroughly with anhydrous sodium sulfate and three portions of 3:1 acetone-alcohol mixture—a ten cc portion followed by two five cc portions. The acetone, alcohol and liver are placed in a centrifuging tube together with 15 cc of anhydrous ether. The mixture is shaken for ten minutes, centrifuged and the supernatant evaporated in a partial vacuum under nitrogen. The cholesterol is determined by means of the Leibermann-Burchard test with the Evelyn photoelectric colorimeter.

The above method produces more consistent results than a modification of the Bloor method.

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# DISCUSSION

## THE EFFECT OF THIOURACIL ON TISSUE OXIDASE

WE have read with great interest the paper entitled "The Effect of Thiouracil on the Respiration of Bone Marrow and Leucocytes *in vitro*," by Dr. Charles O. Warren.[1]

We have recently studied the influence of thiouracil, sulfonamides and a number of other compounds on the cytochrome oxidase (paraphenylendiamine oxidase) of the thyroid gland of the rat.[2] Thiouracil in 0.002 M solution added to thyroid tissue *in vitro* inhibits the oxidase activity significantly (decrease

[1] SCIENCE, 102: 174, August 17, 1945.

* Contributions from the Department of Zoology, Smith College, No. 212.

[1] W. R. Bloor, *Jour. Biol. Chem.*, 17: 377. 1914.
[2] G. E. Sackett, *Jour. Biol. Chem.*, 64: 203, 1925.
[3] W. R. Bloor, *Jour. Biol. Chem.*, 77: 53, 1928.
[4] J. T. Ireland, *Biochem. Jour.*, 35: 283, 1941.
[5] R. Schoenheimer and W. Sperry, *Jour. Biol. Chem.*, 106: 745, 1934.
[6] F. Foldes, *Jour. Lab. Clin. Med.*, 28: 1889, 1943.
[7] E. C. Noyes, *Biochem. Zeitschr.*, 289: 391, 1938.
[8] A. E. Teeri, *Jour. Biol. Chem.*, 156: 279, 1944.
[9] H. Gershberg and J. C. Forbes, *Jour. Lab. Clin. Med.*, 27: 1439, 1942.

51 per cent. ± 6.3). A significant decrease of oxidase activity was also observed in the thyroid glands of rats treated for 11 to 23 days with thiouracil (0.05 per cent. drinking solution) as compared with the oxidase activity of thyroids of normal controls. Inhibition of the cytochrome oxidase system in the thyroid gland may possibly form the basis for the "antithyroid" effect of thiouracil and sulfonamides. In view of the ubiquity of cytochrome oxidase it would be expected that the antithyroid drugs would exert some influence on a number of tissues. However, approximately 90 per cent. of patients treated with thiouracil show no effects other than suppression of formation of thyroid hormone, and only 10 per cent. show untoward reactions indicative of an influence of the drug on other tissues. In experimental animals most investigators have found little effect from thiouracil on tissues other than the thyroid unless very large doses were employed.

In unpublished experiments we have observed that the cytochrome oxidase activity (paraphenylendiamine oxidase activity) of the bone marrow and of the kidney, which is of the same magnitude as that of the thyroid gland, can not be inhibited *in vitro* by thiouracil in 0.002 M concentrations which significantly inhibit the oxidase system of the thyroid gland. Thiourea in concentrations up to 0.01 M is equally ineffective. Experiments are also now under way to determine the nature of this protective mechanism. The data presented by Warren indicate that the protection of the bone marrow is not absolute but can be overcome by the use of higher concentrations of thiouracil.

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## TEMPERATURES IN SOME DEEP WELLS IN PENNSYLVANIA AND WEST VIRGINIA

THE average temperature gradient, as given by some text-books in geology, is one degree Fahrenheit per 100 feet. The rate of increase varies within wide limits in different parts of the globe. In some places, it is as high as one degree in 30 feet. In the deep gold mines of the Transvaal in South Africa, it is only one degree Fahrenheit in 250 feet. The average for all observations is believed to be about one degree in 60 feet. In the copper mines at Butte, Montana, which are several thousand feet deep, it is uncomfortably warm.

In some wells, a mile and a half deep, the difference in temperature, between top and bottom, is 125 degrees Fahrenheit, or more. The oil well drilled by the Continental Oil Company, known as K.C.L. A.-2, located four miles west of Wasco, near the middle of the San Joaquin valley in California, showed a temperature of 268 degrees Fahrenheit at the bottom, which is 15,004 feet, or nearly three miles below the surface. This is 6,000 feet deeper than the deepest mine in the Rand in South Africa.

The writer has taken the figures for temperature at various depths from deep wells in Pennsylvania and West Virginia, and compiled the results as indicated in Tables 1 and 2. The data were obtained from

TABLE 1

| Location of well | Depth (feet) | Temp. Fahr. at bottom |
|---|---|---|
| Volcano Oil and Coal Co., Wood Co., W. Va. | 4,250 | 113.1 |
| Slaughter Creek Coal and Land Co., Kanawha Co., W. Va., No. 1 Well | 4,730 | 113 |
| Lehigh Portland Cement Co., Lawrence Co., W. Va., No. 1 Well | 5,000 | 126.6 |
| Slaughter Creek Coal and Land Co., Kanawha Co., W. Va., No. 1 Well | 5,230 | 129 |
| W. T. Beidenbach, Armstrong Co., Pa., No. 1 Well | 5,965 | 146.2 |
| J. S. Lightcap, Indiana Co., Pa., No. 1 Well | 6,460 | 153 |
| R. A. Geary (now Sarah Cummings), Washington Co., Pa., No. 770 Well | 6,975 | 144.9 |
| Martha Goff, Harrison Co., W. Va., No. 4190 Well | 7,310 | 158.3 |
| Jacobs Creek Oil Co., Westmoreland Co., Pa., No. 1(3297) Well | 8,080 | 211 |

TABLE 2

| | Depth (feet) | Temp. Fahr. | Temp. difference | Increase in temp. per 100 feet in depth |
|---|---|---|---|---|
| (1) | 8,080 | 211 | | |
| | 4,250 | 113.1 | 97.9 | 2.55 |
| (2) | 5,000 | 126.6 | | |
| | 4,250 | 113.1 | 13.5 | 1.8 |
| (3) | 5,230 | 129 | | |
| | 4,730 | 113 | 16 | 3 |
| (4) | 5,965 | 146.2 | | |
| | 5,000 | 126.6 | 19.6 | 2 |
| (5) | 6,460 | 153 | | |
| | 5,000 | 126.6 | 26.4 | 1.8 |
| (6) | 6,460 | 153 | | |
| | 5,965 | 146.2 | 6.8 | 1.37 |
| (7) | 7,310 | 158.3 | | |
| | 6,975 | 144.9 | 13.4 | 4 |
| (8) | 7,310 | 158.3 | | |
| | 6,460 | 153 | 5.3 | .62 |
| (9) | 8,080 | 211 | | |
| | 7,310 | 158.3 | 52.7 | 6.8 |

"Summarized Records of Deep Wells," West Virginia Geological Survey, Vol. XVI, 1944, by R. C. Tucker. The methods used for obtaining these temperatures is not known to the writer. One important fact brought out by a study of the well records is that the average increase in temperature per 100 feet in depth, from the 4,250 to 8,080 foot level, is 2.77 degrees Fahrenheit. Another interesting feature is the high tempera-

[2] Preliminary report: *Fed. Proc.*, 4: 55: 1945, final paper in press.

ture recorded at the bottom (8,080 feet) of the well in Westmoreland County, Pa. The average increase in temperature from the surface to the bottom of this well is about 1.76 degrees Fahrenheit per 100 feet. The data for all the wells show that the average increase per 100 feet varies considerably and the rate of increase is not uniform.

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## THE MEIGEN 1800 NAMES AGAIN

I EXPECTED my somewhat lengthy discussion of the Meigen 1800 names[1] to be my final one on the subject, but the recent article by William F. Rapp, Jr.,[2] leads me to believe that it was not so widely read as I had hoped. It is rather astonishing that Mr. Rapp finds Opinion 152 of the International Commission on Zoological Nomenclature so important, since it is merely a restatement of Opinion 28. The only difference lies in the fact that there is now a greater body of Opinions, particularly number 46, on which to establish the validity of names which were declared available in 1910.

Opinion 28 was not ambiguous, nor did the commission fail to answer, as well as it was in its power to do so, the question that J. M. Aldrich asked relative to the validity of the Meigen names. One should realize that it was impossible for the commission to state that the Meigen 1800 names were valid, since this would have involved an exhaustive examination of each name to determine its possible homonymy. This was the duty of the dipterists. It is admitted that until Opinion 46 was published in 1912 the status of binary names was in doubt, but after that date it was only necessary for the dipterists to determine the properly designated genotype for each name and to use the name for the genus to which that genotype belonged. A number of workers did this and important publications, particularly in Europe, followed the Rules. The only alternative, if one believed in following legal procedure, was to request suspension of the Meigen 1800 names under the plenary power of the commission. In the 37 years since Hendel resurrected the names I do not know of a single request for suspension of these names having come to the commission. Abrogation of Meigen's 1800 paper is unthinkable, in view of Opinions 28 and 152, although it is possible that a few of the names that have not entered the literature to any extent, or that have been misapplied, might be favorably considered for such action.

The fundamental questions are—Should we accept priority as the basic principle on which zoological nomenclature must rest, and should we accept the genotypes that have been designated for the Meigen 1800 names in accordance with Opinions 46 and 65? The answer to the first would seem obvious. Unless priority is accepted, the way is left open for any one to use whatever names suit his fancy. If we are to have stability, the principle of priority must be jealously guarded, and any suspension of the Rules should be looked upon as weakening the nomenclatorial structure. The answer to the second question is clear except in those cases where there is serious doubt as to the fitness of the genotypes. Where it can not be proved that the genotype designation is incorrect, we must assume that it is correct; where there is good evidence that an error has been made, it becomes necessary, if a change of name appears desirable, to place the case before the commission in accordance with Opinion 65. It is my opinion that we will achieve stability quicker if we accept the genotype designated for each one of the genera and cease to worry about Meigen's descriptions.

One more point should be raised. Mr. Rapp speaks of "Diptera nomenclature." It should be stressed that the commission is dealing with zoological nomenclature and that any principle laid down by the commission applies throughout the animal kingdom in exactly the same manner. It is evident from the 58 per cent. affirmative reply to Edwards's second question, "Do you consider that the omission of specific names renders the Nouvelle Classification names invalid?" that many dipterists either did not know of Opinion 46 or chose not to follow it. It is the duty of zoologists to learn and apply the Rules after they have been made by the commission. Only in this way can we hope to attain stability.

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## RE-EMPLOYMENT OF BIOLOGISTS NOW IN THE ARMY AIR FORCES

DURING the war approximately two hundred physiologists and general biologists have been serving in the Army Air Forces as Aviation Physiologists. These officers have discharged important duties in training, research and testing programs. With the close of the war, they are gradually becoming available for release from military duty, and fifty or more of them will desire teaching or research positions in civilian institutions.

The officers were chosen for this service after a careful consideration of their scientific training and their personal qualifications. Accordingly, they are biologists with wide scientific interests, demonstrated

[1] A. Stone, *Ent. Soc. Amer. Ann.*, 34: 404–418, 1941.
[2] W. F. Rapp, Jr., SCIENCE, 102: 17–18, 1945.

qualities of initiative and leadership and marked aptitudes for teaching or investigation.

During their service in the Army Air Forces the aviation physiologists have had an opportunity to develop certain of those talents and to acquire experience along other lines which should contribute to their success in civilian scientific activities. It is worthy of mention that many of them assumed difficult administrative duties which they handled with notable success. It has been necessary for them to instruct large groups of Air Forces personnel in the biological problems of flight and to arouse the interest of men with little knowledge of elementary science. It has been their duty to apply biology to the practical problems of technological warfare. Of especial significance is their broadened intellectual horizon and a new interest in problems of human biology. This wartime training of a carefully selected group of biologists will enhance their value to teaching and research groups with which they now become associated.

Among the men who are seeking civilian positions there are general physiologists, zoologists, mammalian physiologists, entomologists, embryologists, pharmacologists, anatomists, biochemists, plant physiologists, botanists and museum curators. Each of them holds a doctorate from a well-known university.

The Army Air Forces appreciates the notable effort these scientists have made to establish and execute a pioneer program of great value to our military effort. In order to aid them in their return to civilian occupations, we invite correspondence from teaching and research institutions which have positions available for such individuals.

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# SCIENTIFIC BOOKS

## CULTURE GROWTH

*Configurations of Culture Growth.* By A. L. KROEBER. 882 pp. University of California Press. 1945. $7.50.

IN general the reviewer finds himself in agreement with the author on the following conclusions regarding the "higher values" of esthetic and intellectual endeavor: (a) that they appear in bursts or constellations of genius; (b) that "geniuses are the indicators of the realization of coherent pattern growths of cultural value" (p. 839), which follow from the belief "that all human beings are the products of their culture to a much greater degree than we ordinarily imagine" (p. 838). The continuation of the preceding sentence, "and that cultures appear to grow in patterns and to fulfill or exhaust these," however, raises questions in the reviewer's mind which this book does little to answer. It is true that the author adds, "Why cultures behave in this way, especially in their intellectual, esthetic, and nationalistic aspects, is not clear; but it seems to be one of their most distinctive properties" (p. 838).

This savors a little of the mysticism of which he earlier, and rightly, accuses Spengler. Is there some pattern of culture growths ordained which must be fulfilled or exhausted? I see no reason why we should believe this to be the case, why "accidental" events should not be allotted a large share in the determination of cultural patterns. I use "accidental" here not in the sense of uncaused events but rather in the sense of events which, with existing knowledge, can not be seen as the necessary outcome of the existing historical situation. As one who likes to believe he is a scientist I can see no place either for belief in "pure accident" in human history or for an ordained order of development which man can not change by his own actions. Whether he can change it as he would wish is another matter.

Just as Kroeber's view of genius leads him to assume that most people with the innate capacity of great cultural achievement are "never realized" because there is nothing in their cultural inheritance which demands their particular genius, so one might argue with equal cogency that there is many a period in history when cultural achievement is low because there does not happen to be some genius to synthesize the cultural patterns into some structure which posterity will recognize as significant. In other words, I can accept Dr. Kroeber's interpretation of the role of genius in the development of culture without accepting any particular growth of culture as inevitable in the sense that man can not modify it if he so desires. Perhaps these are contradictory conceptions, but they do not seem so to me.

But if there is something inevitable about the growth of any particular cultural configuration and if it is the fulfilment of some promise contained in its early conception, then this compulsion must be exercised by the customs, attitudes of mind and institutions of the given community and they in turn must have something inevitable about their development. That this is the case I can not believe, nor do I think Dr. Kroeber believes this; hence, I am puzzled to account for what appears to me to be a frequent reiteration of the idea that cultures fulfil and exhaust their patterns. If all this means is that when cultural

achievements no longer express vital aspects of community life they no longer have "higher value," well and good; but if he means that these "higher values" which come to fruition are inherent in the early phases of a culture and are the only possible outcome of these early phases, then I can not follow. This is what I mean when I say this view savors of mysticism.

Many questions are inevitably raised by such a discussion of culture. Why are science and philology considered integral parts of cultural patterns while technologies (agricultural and industrial, and those dealing with communication and transportation) are omitted? Why is music considered a "higher value" than the invention of a loom or a wheel or a new system of taxation? After all, the "higher values" treated of in this essay are of little importance to mankind as a whole when compared with the values of social and economic changes which apparently are excluded from "Configurations of Culture Growth." The real surprise of the book is to find an anthropologist using "culture" in the narrow sense of those arts and intellectual pastimes which have never concerned more than a small group of the intellectually and socially elite.

This is a stimulating essay and one which will provoke considerable reaction, but as a foray into the frontiers of sociology by anthropology, which recently shows much inclination to regard itself as the fundamental social science, it leaves much to be desired.

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## CHEMICAL EMBRYOLOGY

*Embryologie Chimique.* By JEAN BRACHET. 509 pp. Liege: Editions Desoer; Paris: Masson & Cie. 1944.

THE appearance of this book is one of the most pleasant surprises that has followed V-E day. Even for normal times this would be considered an excellent book. But having been written and published during the German occupation of Belgium, under the difficult conditions which we now know prevailed there, with an unpleasant sojourn in prison by the author, as a hostage, it is all the more remarkable. It is, in fact, hard to see in what ways this text could be improved, or better serve the purpose for which it was written.

The author states that his book is aimed at biologists or those with some biological knowledge (an elementary knowledge of organic chemistry and biochemistry is also implied) and hopes to be able to attract some of them into the fertile field of chemical embryology. It is written in a simple and direct style and should be readily intelligible to any one with an elementary knowledge of French.

The field of chemical embryology may be said to have been established as a separate entity by Joseph Needham as a result of the publication in 1931 of his monumental, three-volume treatise with that title. It is perhaps an unfortunate designation, for it may imply simply a description of the chemical substances present in embryos in the sense that morphological embryology means a description of the form of embryos. That Needham did place much emphasis on that line of work is understandable in view of the lack, up to that time, of any coordinated treatment of the data pertaining to the chemical constitution of the developing egg. It is of interest to note, however, that Needham's recent work along this line is entitled "Biochemistry and Morphogenesis." It is evident that the analysis of development must proceed at the biological as well as at the chemical level and that it often involves both levels of investigation at the same time; for some of the most interesting modern work is that in which chemical techniques and the more classical methods of experimental embryology are combined. Brachet, despite the title of his book, is quite evidently fully aware of this, and has, in fact, written a well-rounded treatment of the recent work in experimental embryology. He did not have access to Needham's new book (1942) which covers essentially the same ground. Perhaps this is fortunate, for it is especially valuable to have such a text written without the strong influence exerted by one of the most prolific writers of our time. As a result more significance can be attached to the similarities as well as to the differences that appear in their discussion, evaluation, interpretation and criticism of the same material.

The first chapter in Brachet's book describes methods that have been employed to determine, locate and follow changes in various chemical constituents. Included are succinct accounts of the techniques devised by Linderstrøm-Lang and Caspersson. Chapter II deals with the chemical basis of the determination of sex. Here much space has been given to the work of Moewus and Kuhn on Chlamydomonas. To the reviewer, who has heard much private comment on the shortcomings of that work, and has seen some published criticism such as that of Philip and Haldane, the emphasis given to it by Brachet seems somewhat out of proportion, particularly since independent confirmatory evidence is still lacking. Chapters III, IV and V concern the ripening of the gametes, fertilization and segmentation. Minor criticism may be leveled here at his adoption of the unnecessary and unsatisfactory terms andro- and gynogamones coined by M. Hartmann. If one wishes to avoid the implications of Lillie's *fertilizin,* then *ovulin* used by Dalcq and a corresponding term *spermulin* are available.

More serious criticism may be made in regard to Brachet's acceptance of the demonstration of a chemotactic response of sperm to egg water on the basis of capillary tube experiments. Jennings, Morgan and others had long ago pointed out the inadequacy of that method and had emphasized the pitfall of trap-action. Chapter VI is a departure from this sequential presentation of developmental phenomena and consists in a discussion of the nucleic acids, a subject to which Brachet has made many outstanding contributions. Growth, differentiation and metabolism, from the viewpoint of the energetics of these processes, comprise the subject-matter of Chapter VII. In Chapters VIII and IX metabolic experiments and measurements on developing eggs of invertebrates and of batrachians respectively are discussed. In Chapter X the extensive and highly controversial work on the metabolism of the "organizer" and on the chemical nature of the inductive substance is presented with admirable objectivity considering the fact that some of the author's own work is involved. An excellent and apparently successful attempt is made to reconcile the differences in results obtained by various workers in this technically difficult field. Chapter XI contains a brief treatment of the recent work on regeneration. Chapter XII is an attempt to draw some general conclusions and present potentially fertile lines of research.

Although Brachet did not have access to publications in the Allied countries after the occupation of Belgium, this lack is not particularly noticeable, and the book is on the whole quite up-to-date. It is exceptionally free of factual errors and is well indexed.

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## RADIO

*Principles of Radio.* By KEITH HENNEY. 5th edition. New York: John Wiley and Sons, Inc. 1945.

FOLLOWING a brief survey of the latest edition of "Principles of Radio," the reviewer recalled years now long past when he read avidly books like Stuart Ballantine's "Radio Telephony for Amateurs" (1922) and Elmer Bucher's "The Wireless Experimenters' Manual" (1920). Mr. Henney's first edition, published in 1929, was a notable addition to this class of useful books.

There is an emphatic trend toward the presentation in engineering curricula of larger and larger amounts of mathematical physics; this trend has proceeded with increasing acceleration during the past fifteen years. In the fields of radio and electronics there has been a parallel development: many young men who did not undertake the study of electrical engineering nevertheless proceeded to work in these fields; and therefore sought information which would enable them successfully to solve the problems which they faced. It is to such men that Mr. Henney has directed his book. How successful he has been is best demonstrated by the fact that five editions of the book have been launched in a period of sixteen years. In recent years his book had been useful not only to radio amateurs and to radio servicemen, but also to those who want to learn something about radio after working many years in some other field.

It is always difficult for an author to produce a useful book which is at once elementary and rigorous. Mr. Henney has achieved a nice balance; quite rightly when rigor demands a very complicated explanation, he chooses a simple explanation that best helps his reader. Thus the book is very compact. In his first chapter—entitled "Fundamentals"—he reviews atomic theory and the electrical components of the atom, units of measurement of electric current and charge, the expression of large and small numbers as powers of ten, the plotting of curves and electrical symbols. He then proceeds with a well-illustrated discussion of direct-current circuits, magnetic fields and alternating-current circuits. In Chapter 11, he begins his description of vacuum tubes and the circuits in which they are used. This leads naturally into an analysis of radio transmitters and receivers. The last part of the book is devoted to material—new in this edition—on frequency modulation and ultra-high-frequency phenomena.

The most important characteristic of this book is the choice of problems and the choice of the method for presenting them. It is clear that Mr. Henney either has faced these problems in the same manner as his reader or that he knows precisely what it is that most confuses the neophyte in radio. Step by step he answers the questions in the order in which they are likely to arise in the minds of the amateur or serviceman. This is, of course, the key to the success of the several editions. It is to be hoped that Mr. Henney will continue in later years to bring his book up to date in the manner which he has so successfully followed during the last fifteen years.

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## BOOKS RECEIVED

BOYER, LEE EMERSON. *An Introduction to Mathematics for Teachers.* Illustrated. Pp. xvii + 478. Henry Holt and Company, Inc. $3.25. 1945.

LIDDELL, DONALD M. *Handbook of Nonferrous Metallurgy.* Second edition. Illustrated. Pp. xi + 655. The McGraw-Hill Book Company. $6.50. 1945.

*Procedure Handbook of Arc Welding Design and Practice.* Eighth edition. Illustrated. Pp. xii + 1282. The Lincoln Electric Company. $1.50. 1945.